Retroseptal structural fat grafting to correct paediatric post-traumatic enophthalmos

G Spinelli¹, F Arcuri¹*, D Lazzeri², L Salvagni³, T Agostini⁴

Abstract

Introduction
Orbital volume deficiency is caused by various diseases and it can be present in different clinical scenarios. Orbital volume replacement in the post-traumatic enophthalmos is currently addressed by different surgical methods. Several autologous tissues and alloplastic materials have been used. The purpose of this article is to introduce our experience in the management of 8 complex cases of post traumatic enophthalmos treated successfully by retroseptal autologous fat grafting.

Case series
To address the research purpose, we designed a retrospective case series. Our study was based on 8 patients (mean age 10.5 years: range, 5-16 years; 6 males and 2 females) who underwent fat grafting for postoperative orbital defect. All patients had monolateral amaurosis and post-traumatic enophthalmos. Postoperative follow-up was recorded at 1 week and at 1, 3, and 6 months with an accurate physical examination and clinical photography. We evaluated the outcome of these surgical procedures by measuring the morphological change of the face with a software package (Adobe Photoshop, Microsoft Corporation, CA). The preoperative photograph of the healthy side of the face has been reflected with the software to obtain the virtual ideal face (VIF). Postoperatively, we compared the VIF with the postoperative photograph. We obtained a similar facial morphology in 6 patients.

Discussion
Fat grafting in the intraconal space has been described in the treatment of enophthalmic orbit using a sharp needle. Hunter investigated the effects of intraconal fat grafting in patients with post-traumatic enophthalmos; it was used either in patients with a healthy eyeball or in those with anophthalmic sockets and he stated that enophthalmos is stabilized within the first 3 months with this technique. He obtained overall good results, but in 64% of cases, multiple injections were necessary. Malet described a consistent number of patients with anophthalmic sockets treated by injection into the deep upper eyelid sulci. Hardy described a retrospective study on 12 patients with anophthalmic and enophthalmic orbital cavity.

Conclusion
Fat grafting can be safely carried out in the treatment of the enophthalmic orbit. It has a long-lasting effect and can be a valid alternative to other autologous tissues or alloplastic materials.

Introduction
Orbital volume deficiency is caused by various diseases and it can be present in different clinical scenarios. Frequently, it arises after the enucleation/evisceration of an eye and it can be the consequence of phthisis bulbi or congenital anophthalmos/microphthalmos.

Moreover, soft tissue deficiency of the orbit can be associated to irradiation/inflammation, Parry-Romberg syndrome, and postsurgical blepharoplasty. Finally, soft tissue volume deficiency may result from orbital decompression and orbital fracture.

Orbital volume replacement is currently addressed by different surgical methods. Several autologous tissues have been used such as: 1) fat grafting; 2) costal cartilage; 3) cancellous/cortical bone. Regarding alloplastic materials, the most common choices are: 1) porous polyethylene; 2) glass beads; 3) silicon blocks/gel; 4) hydroxyapatite; 5) metallic implants.

Each of the two supra mentioned methods carry different advantages and disadvantages. Alloplastic materials do not present significant rate of absorption; however, they are associated with serious risks of infection, migration, and foreign body/fibrotic reactions. Autologous tissues cause less postoperative complications; however the rate of absorption is higher when compared to alloplastic materials. Moreover, the donor site morbidity needs to be considered. The main clinical features of orbital volume deficiency are characterized by a sunken appearance of the globe/ocular prosthesis with a deepening of the superior eyelid sulcus and asymmetry of the position of the eye.

The purpose of this article is to introduce our experience in the management of 8 complex cases of post traumatic enophthalmos treated successfully by retroseptal autologous fat grafting. The specific aims of this study are to analyse the outcome of this surgical procedure by measuring the morphological changes of the face with a software package.

Moreover we analysed the postoperative complications and the patient’s satisfaction.

Case series
Materials
To address the research purpose, we designed a retrospective case series. The study population was composed of

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all paediatric patients (0-16 years) who underwent fat grafting to correct post-traumatic enophthalmos from 2008, January to 2012, December at the Unit of Maxillofacial Surgery of the "Careggi Hospital" and at the Cranio-Maxillo-Facial Unit of the paediatric hospital "Meyer", Florence. A clinical evaluation of soft and hard periorbital tissues associated to patient’s anamnesis focused on the trauma process and surgical history was assessed. Preoperative photographs and computed tomography (CT) scan were analysed. They permit us to carefully evaluate the changes of orbital volume and to understand the depthness of injection without damaging the optical nerve and the other neurovascular structures. The inclusion criteria were post-traumatic enophthalmos, amaurosis, loss of orbital tissue, and retracting scars. The exclusion criteria were visual acuity preserved, poor general health, and psychic disorders.

**Fat harvesting and fat transfer**
Under general anaesthesia we harvested the fat from the abdomen through an umbilical access by a dry technique (mean volume 14 mL) and we processed it by centrifugation for 3 minutes at 3000 rpm in a sterile environment; we eliminated the infranatant (blood and lidocaine) and the supranatant (lysed fat cells). Finally we transferred the purified fat graft into 1-cc Luer Lok syringes. (Figure 1)

**Retroseptal fat injection**
We injected with a blunt-tipped cannula (1 mm in diameter) a mean volume of 3.5 mL of purified fat into the enophthalmic orbits. A 3-mm linear stab incision was performed at the level of the inferior orbital rim. The cannula was inserted through the skin and was advanced over the orbital floor to avoid vascular and/or neuronal lesions. An approximate deepness of 2 cm was reached. We transplanted the fat as micrografts in a fan-shape style in the extraconal and intraconal compartments to correct the enophthalmos. Assuming an absorption of approximately 30% of the volume, a mild overcorrection was performed.

8 patients matched our criteria (mean age 10.5 years: range, 5-16 years; 6 males and 2 females). The postoperative orbital defect of each patient was managed by fat grafting. All patients had monolateral amaurosis and post-traumatic enophthalmos. Postoperative follow-up was recorded at 1 week and at 1, 3, and 6 months and 12 months with an accurate physical examination and clinical photography. (Table 1)

We evaluated the outcome of these surgical procedures by measuring the morphological change of the face with a software package (Adobe Photoshop, Microsoft Corporation, CA). The preoperative photograph of the healthy side of the face has been measured.
reflected with the software to obtain the virtual ideal face (VIF).

Postoperatively, we compared the VIF with the postoperative photograph. For each patient, VIF and postoperative images have been analysed by 5 blinded clinicians (maxillofacial consultant) to establish the equality of the photographs. A score of 1 to 5 was assigned to determine the outcome of this procedure: (1) very different, (2) different, (3) similar, (4) very similar, (5) identical. The objective evaluation was possible by comparing the VIF to the postoperative face with the aid of a software package. We obtained a similar facial morphology in 6 patients (75%) who received scores of > 3. Two patients (25%) were scored as different (< 3).

The major rate of fat absorption was assessed in the immediate three months after surgery; however, at one year follow up after facial fat grafting, all patients showed a stable recovery, without further recovery. The average length of stay was one day and the recovery was well tolerated by all patients. (Figure 1, 2, 3, 4, 5, 6 and 7). Apart from postoperative discomforts such as bruising, swelling and pain, we did not have major complications such as infection, haemorrhage and stroke. All patients were satisfied with the postoperative orbital morphology and with the recovery time; we did not have any complaints.

**Discussion**

The posttraumatic enophthalmic socket is a surgical challenge because of the difficulty to restore an adequate morphology, associated to the risks of ocular motility disturbance, visual loss, embolism and other neurovascular complications. Several studies have stated that the degree of enophthalmos is correlated with the loss of intraconal fat. Manson calculated the fat volume in CT sections and he underlined a 5% retrobulbar fat reduction in the enophthalmic cases. Ramieri stated that the posterior fat is reduced and fragmented by scarring tissue. Ilankovan confirmed that, as retrobulbar fat represents the majority of the orbital volume (approximately 70%), fat atrophy and necrosis play an essential role in the development of enophthalmos.

![Figure 5: Intraoperative sequence demonstrating extensive reconstruction of the defect.](image1)

![Figure 6: Preoperative view before fat injection.](image2)

![Figure 7: Postoperative photograph demonstrating the correction of the enophthalmos.](image3)

**Table 1: Characteristics of the paediatric population who underwent fat grafting at our institution.**

<table>
<thead>
<tr>
<th>PATIENTS</th>
<th>GENDER</th>
<th>AGE</th>
<th>BONES</th>
<th>DONOR SITES</th>
<th>PROCEDURES</th>
<th>ANAESTHESIA</th>
<th>COMPLICATIONS</th>
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Fat grafting is a simple technique, requiring cannulae and a centrifuge. We injected small amounts of fat during the withdrawal of the needle by multiple passes at different anatomical levels of the orbit. We used this technique in our 8 cases; we injected in the retroseptal space, rather than superficial to the orbicularis oculi muscle, in order to prevent the possibility of irregular lumps. Because adequate oxygen and nutrients must reach the grafted tissue, it is necessary that the graft is well perfused.

Due to the high vascularity of the orbit and periorbital tissues, there is also the possibility of globe perforation, optic nerve damage and intravascular injection with fat embolism, which may lead to blindness or stroke.19

The paucity of scientific literature regarding fat grafting is explained by the common use of other materials for soft-tissue reconstruction. Moreover, fat grafting has the reputation to give unpredictable long-term results. Post-traumatic enophthalmos can be treated by autologous, homologous, heterologous, and alloplastic materials.

Regarding autologous tissue, bone grafting and cartilage fragments have been used; among homologous materials, the most used is collagen. The most common heterologous material is the lyophilized dura; regarding alloplastic materials, silastic, hydroxyapatite blocks, expanded porous polyethylene, metallic implant and tissue expander are described in the scientific literature.3,4,5,6,7,8,9,26

Orbital reconstruction with autologous bone graft has the advantage that it becomes vascularized and incorporated into the facial skeleton, avoiding extrusion and infection. The disadvantage is that the graft has a degree of absorption, making globe position unpredictable. Clinical experience suggests that calvarial grafts tend to resorb less than grafts taken from other donor sites such as ilium or rib which are predominantly cancellous. However, bone graft is difficult to shape and control during internal orbit reconstruction and postoperative complications can be serious especially for calvarial grafts.22

Regarding cartilage grafts, Nishi23 have successfully described sliced costal cartilage for the treatment of late post-traumatic enophthalmos by placing the grafts below the subperiosteum posteriorly to the equatorial plane. Lee4 has published the use of diced-cartilage graft to reconstruct the orbital volume.

Even collagen gives unsatisfactory results because of its absorption and surgical problems related to inflammation and immunological reactions. Moreover, its use in the orbital zone has a documented risk of blood vessels occlusion leading to visual damage.20 Hydroxyapatite blocks have a major stability and availability. However, there are some disadvantages with the use of these materials similar to collagen.

Yaremchuk used expanded polyethylene to reconstruct the orbit. He advocated that this implant has a pore size which allows vascular ingrowth and some incorporation into the recipient bed. In his experience of 70 patients he did not report any infection or graft extrusion. Metallic implants with a variable number of designs are fixed to the orbital rim and are used to reconstruct large defects. The implant can be used alone to restore the orbital anatomy or may serve as a platform to place other grafts.23

Zhang24 demonstrated the use of computed tomography-based mirroring reconstruction of the orbit in 22 patients with late posttraumatic enophthalmos.

An anatomically adaptive titanium mesh was fabricated by computer-aided design and a computer-aided technique. He25 advanced the technique by using a navigation-guided surgery with a 3D model, and titanium mesh for the treatment of orbitozygomatic fractures with severe enophthalmos.

**Conclusion**

Fat grafting can be safely carried out in the treatment of the enophthalmic orbit. It has a long-lasting effect and can...
be a valid alternative to other autologous tissues or alloplastic materials. Fat grafting is a choice for volume restoration because of its physiological presence into the orbit with low donor site morbidity when compared to other reconstructive procedures. It presents less risk of rejection, sensitivity reaction, sterile abscesses or nodules formation when compared to other injectable fillers (collagen and hyaluronic acid).

However, there is a paucity of scientific publications in this specific field and particularly for paediatric patients. More sophisticated clinical studies, eventually enriched by radiological investigations are necessary to better understand the biology of the transplanted fat into the orbital cavity.

Consent
Written informed consent was obtained from all patients for publication of this series study and accompanying images. A copy of the written consents is available for review by the Editor-in-Chief of this journal.

References